***PATENT***

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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| **Applicant:** | Jiang, et al. | **Art Unit:** | 1775 |
| **Serial No.:** | 10/821,023 | **Examiner:** | Jason L. Savage |
| **Filed:** | 04/07/2004 | | |
| **Docket No.:** | A369-USA | | |
| **For:** | Brazing Titanium to Stainless Steel Using Ti-Ni Filler Material | | |

**VIA EFS-WEB**

**Mail Stop Appeal Brief - Patents**
**Commissioner for Patents**
**PO Box 1450**
**Alexandria, VA 22313-1450**

## APPEAL BRIEF (37 C.F.R. § 41.37)

This brief is in furtherance of the Notice of Appeal, filed in this case on March 16, 2006.

The fees required under § 41.20, and any required petition for extension of time for filing this brief and fees therefor, are dealt with in the accompanying TRANSMITTAL OF APPEAL BRIEF.

### I. REAL PARTY IN INTEREST

The real party in interest in this appeal is: The Alfred E. Mann Foundation, a California Corporation, by virtue of an assignment from the inventors, recorded April 7, 2004 at Reel 015202, Frame 0888.

### II. RELATED APPEALS AND INTERFERENCES

With respect to other appeals or interferences that will directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal: there are no such appeals or interferences.

### III. STATUS OF CLAIMS

### A. TOTAL NUMBER OF CLAIMS IN APPLICATION

Claims in the application are:

13

### B. STATUS OF ALL THE CLAIMS

1. Claims cancelled:

   14 to 30

2. Claims withdrawn from consideration but not cancelled:

   none

3. Claims objected to:

   none

4. Claims allowed or confirmed:

   none

5. Claims rejected:

   1 to 13

### C. CLAIMS ON APPEAL

The claims on appeal are:

1 to 13

### IV. STATUS OF AMENDMENTS

An amendment after final was filed by appellants on February 9, 2006. The amendment was entered and an explanation of how the new or amended claims would be rejected was provided by the examiner in a mailing dated February 28, 2006.

### V. SUMMARY OF CLAIMED SUBJECT MATTER

Claim 1 is the sole independent claim, and claims 2-13 are dependent on claim 1. Paraphrasing claim 1, the invention relates to an assembly that is

implantable in living tissue consisting of a stainless steel metal part and a titanium metal part that are bonded together a with metal filler, the filler being comprised of at least one nickel metal foil layer and at least one titanium metal foil layer.

To facilitate review, the specification has been edited to include all changes to the specification and claims from the amendment of October 3, 2005 and the amendment after final of February 9, 2006. The edited specification is included as Appendix XI, A. Line numbers have been added to indicate each line. The Figures are included as Appendix XI, B and are exactly as submitted with the amendment after final of February 9, 2006. All references herein are to the edited specification and to the Figures as included in the Appendix XI.

Fig. 1 is discussed at page 1, line 27 to page 2, line 2, which presents the component assembly 2, titanium metal part 4, and stainless steel part 6 with the laminated filler material 8 interposed between the titanium 4 and the stainless steel 6 parts.

The laminated filler material 8 is discussed at page 2, line 4 to page 3, line 25. It is taught as a laminate metal foil having a thickness of about 0.010 inches or less, page 2, lines 4-6. The laminated filler material 8 is described as pure titanium and nickel laminate, where the filler material 8 has a composition of about 22% to 98% nickel and the balance is titanium [page 2, lines 13-15].

A preferred filler material 8 is presented in Fig. 3 and is discussed on page 2, lines 17-26. The filler is comprised of alternating foil layers of a pure nickel layer 12 and a titanium foil layer 14. The individual foil layers are described as having thicknesses greater than approximately 0.003 inches [page 2, lines 23 to 26]. Fig. 3 presents a foil laminate filler material 8 where a preferred embodiment [page 2, lines 17-26] nickel layer 12, titanium layer 14, are stacked to have an outer surface 42 and a bottom outer surface 44.

Fig. 4 presents a foil laminate filler material 8 where metal foil layers 15, 15', 15" are interspersed with separate inner mating foil layers 17, 17'. A preferred embodiment is described [page 3, lines 11-16] where the metal foil layers 15, 15', 15" are comprised of nickel and are the top outer surface 42 and the bottom outer surface 44. The alternating layers of inner mating foil layers 17, 17' are comprised

of titanium in this preferred embodiment.

Applicants teach that the term "laminated" is preferred to other descriptions of the filler material 8 [page 2, lines 28-29]. Further, the invention teaches that the laminated filler material 8 is not an "alloy" [page 2, lines 30-31] and therefore the laminated filler material exhibits a depressed melting point. [page 3, lines 2-4]

The benefit of placing the nickel foil on the outer surface of the laminated filler material 8 is taught at page 3, lines 11-16.

An alternate embodiment is taught [page 4, lines 5-10] where the foil filler material 8 is instead a thin coating that is applied to the bonding surface of the titanium part 4 or stainless steel part 6.

A further alternate embodiment is taught [page 4, lines 12-17] where filler material 8 is applied as a thin coating of metallic beads, metallic powder, or discrete particles.

## VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Chang et al. (US 6,722,002).

Claim 13 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Chang et al. (US 6,722,002) in view of Cusano et al. (US 3,994,430).

Claims 1-12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over the admitted prior art in view of Chang et al. (US 6,722,002).

Claim 13 stands rejected under 35 U.S.C. 103(a) as being unpatentable over admitted prior art in view of Chang et al. (US 6,722,002) as applied to claims 1-12 and in further view of Cusano et al. (US 3,994,430).

## VII. ARGUMENT

A. Claims 1-12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Chang et al. (U.S. Pat. No. 6,722,002).

Appellants elect to argue claims 1-12 as a group.

Chang et al. US 6,722,002, hereinafter Chang, fails to teach or even

suggest the invention claimed by Appellants. Appellants further argue that Chang relates to non-analogous art. Chang also teaches away from the use of nickel as the outside "fraying face" when he teaches that copper has several advantages over nickel. [Chang col 8, lines 7-13]

Appellants teach a component assembly where one element of the assembly is a filler material comprising at least one nickel foil layer and at least one titanium foil layer for bonding the assembly together. Chang teaches a roll bonding method of cold-rolling without annealing to generate a multi-layer alloy strip or foil made up of discrete layers of titanium and nickel or copper [Chang Abstract]. Chang therefore does not teach the component assembly taught by Appellants. The Examiner concedes this important point and states in the Office action [December 13, 2005 at page 3, last paragraph], "Chang does not exemplify an embodiment wherein a component assembly comprises a stainless steel part bonded to a titanium part via a filler layer comprising nickel and titanium foils." Appellants restate that Chang does not teach all of the elements of Appellants' invention.

The Examiner contends that "it would have been within the purview of one of ordinary skill in the art to have recognized that one could form a composite wherein a stainless steel part was bonded to a titanium part via the recited filler layer...." [Office action December 13, 2005, page 3 last paragraph]. The Examiner has not put forth any evidence to support the contentions advanced.

During patent examination, the U.S. Patent Office bears the initial burden of presenting a *prima facie* case of unpatentability. See *In Re Oetiker*, 977 F.2d 1443, 24 U.S.P.Q. 2d 1443 (Fed. Cir. 1992). When the U.S. Patent Office fails to meet this burden, the appellant is entitled to the patent. However, when a *prima facie* case is made, the burden shifts to the appellant to come forward with evidence and/or arguments supporting patentability. Patentability *vel non* is then determined on the entirety of the record, by a preponderance of the evidence and the weight of the argument. See *In Re Baisecki*, 745 F.2d 1468, 223 U.S.P.Q. 785 (Fed. Cir. 1984).

The burden of establishing a *prima facie* case of obviousness thus rests

upon the Examiner and can only be satisfied by showing an objective teaching in the prior art or by knowledge generally available to one of ordinary skill in the art that would have led such individual to combine the relevant teachings of the cited references. It is error to reconstruct the appellant's claimed invention from the prior art by using the appellant's claim as a "blueprint". For the reasons discussed, the single prior art reference cited by the Examiner does not suggest the invention, as a whole, defined by claim 1 in the above-captioned application.

Chang relates to non-analogous art. The <u>roll bonding method</u> taught by Chang to form a multi-layer alloy strip or foil made up of discrete layers uses a cold-rolling process without annealing. [Chang Abstract] Conversely, Appellants teach a <u>brazing method</u> of forming a component assembly in which a foil filler material is used. These are fundamentally separate and distinctly different metallurgical processes which are undertaken in different steps to provide different end products. Chang teaches roll bonding a layered composite that causes bonding by virtue of the application of extremely high pressure to the combination of the layers at a moderate temperature [that is, a temperature that is much lower than that required for brazing]. [Chang col 6, lines 44-64] Roll bonding is limited to simple shapes, such as flat sheets or plates of material, while brazing is applicable to complex geometry parts. In contrast to roll bonding, brazing, as taught by Appellants, results in a metallurgically joined product in which a braze foil diffuses by solid-state diffusion and thereby integrates into the adjacent stainless steel and titanium parts.

Since Chang is non-analogous art in the field of metallurgy, since it relates to roll bonding, it is therefore not a reference that one skilled in the brazing art would consult in search of teachings related to brazing. Further, Chang does not teach bonding of stainless to titanium, as previously discussed.

Even if the Board determines that Chang is analogous art, and assuming arguendo that Chang may be considered by one skilled in the art, Chang conspicuously limits his teachings to exclude brazing stainless steel to titanium and does not teach all of the elements taught by Appellants. The Examiner cannot consider that it is obvious to do that which is contrary to what Chang teaches.

Chang does not address and actually taught away from Appellants' brazed component assembly of stainless to titanium by means of a laminate braze material therebetween.

Chang teaches away from the use of titanium and teaches "...there are several advantages of having the Cu layer as the fraying face, and thus the use of Cu as the fraying face layer is often preferable." [Chang, col 8, lines 7-13]

Each of the dependent claims 2-12 are dependent on claim 1 and each has support in the specification and drawings. Appellants elect not to argue each dependent claim separately since they are allowable as further limitations on an allowable claim 1.

B. Claim 13 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Chang et al. (US 6,722,002) in view of Cusano et al. (US 3,994,430).

Claim 13 depends from allowable claim 1 and therefore is allowable as well and for the additional limitations contained therein.

Claim 13 is directed to the at least one nickel foil layer and the at least one titanium foil layer that are formed from metallic particulate. Chang is silent regarding this teaching [Office action 12/13/05 page 6, last paragraph].

Cusano et al. (U.S. Pat. No. 3,994,430), "Cusano" hereinafter, teaches a method of introducing a metal in a particulate form on either the substrate or the metal, where the substrate and the metal are juxtaposed in position prior to being bonded as the process proceeds. To restate, Cusano teaches putting metal particles directly on the substrate or metal to be bonded together. Cusano does not teach the use of a laminate foil nor does Cusano teach the method of making a laminate foil from metal particulate.

Even if the Board finds that Cusano is a proper reference, the combination of Chang and Cusano is improper. In determining the propriety of a rejection under 35 U.S.C. §103, it is well settled that the obviousness of an invention cannot be established by combining the teachings of the prior art, absence some teaching, suggestion or incentive supporting the combination. See *In Re Fine,* 837

F.2d 1071, 5 USPQ 2d 1596 (Fed. Cir. 1998). A test for obviousness is what the combined teachings of the references, taken as a whole, would have suggested to those having ordinary skill in the art. See *In Re Kaslow,* 707 F.2d 1366,217 U.S.P.Q. 1089 (Fed. Cir. 1983).

"To prevent the use of hindsight based on the invention to defeat patentability of the invention, this court requires the Examiner to show a motivation to combine the references that create the case of obviousness". *In Re Rouffet*, 149 F.3d 1350, 47 U.S.P.Q. 2d 1453 (Fed. Cir. 1998). "(T)he suggestion to combine requirement stands as a critical safeguard against hindsight analysis and rote application of the legal test for obviousness". *In Re Rouffet*, supra.

In analyzing whether claimed subject matter is properly rejected under 35 U.S.C. §103(a) based upon a combination of prior art references, two factors must be considered: (1) whether the prior art would have suggested to one or ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and (2) whether the prior art would also have revealed that in so making or carrying out, those of ordinary skill would have a reasonable expectation of success. *In Re Vaeck*, 947 F.2d 488, 20 U.S.P.Q. 2d 1438 (Fed. Cir. 1991).

Not withstanding the fact that his rejection of claim 13 is based upon the combination of Chang and Cusano, the Examiner acknowledges that Chang does not teach a component assembly comprised of a stainless steel part bonded to a titanium part by means of a filler layer comprising nickel and titanium foils. [Office action of 12/13/05, page 3, last paragraph; page 5, second full paragraph] Further, Chang does not teach at least one of the filler layers being formed from metallic particulate. [Office action of 12/13/05, page 6, last paragraph] Cusano does not teach formation of a foil or of a laminate. The Examiner agrees and states, "Cusano further teaches that a bonding agent may be used to bond the metal part to the other metal part and that the agent may be in particulate form (col. 3, ln. 20-30)." [Office action of 12/13/05, page 6, last paragraph]

Even in view of his acknowledgements, the Examiner still persists in combining Chang with Cusano in the absence of any express motivation to do so.

As was held in *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 60 U.S.P.Q. 3d 1001 (Fed. Cir. 2001), "The genius of invention is often a combination of known elements which, in hindsight, seems preordained. To prevent hindsight invalidation of patent claims, the law requires some 'teaching, suggestion or reason' to combine the cited references." No teaching, suggestion or reason to combine is offered by the references being cited. Further, there is nothing to indicate that anyone, not relying on hindsight, would, from the two references cited, arrive at the invention set forth in appellant's claim 1.

C. Claims 1-12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over the admitted prior art in view of Chang et al. (US 6,722,002).

Appellants argue that claim 30, in Jepson claim format, can not be cited as admitted prior art against the allowability of claims 1-12. Firstly, claim 30 has been withdrawn and cancelled. Secondly, the preamble describes Appellants' own work and therefore is not eligible as prior art under the present conditions. See for example U.S. Patent Application No. 10/793,536 "Brazing Titanium to Stainless Steel Using Nickel Filler Material" referenced in the instant application under Cross Reference to Related Application. [Application, page 1]

Appellants stated in the amendment of October 3, 2005 at page 7, second full paragraph:

> Jiang claim 30 is a Jepson claim that describes the **prior art that Applicants have practiced and that is know[n] to Applicants** and the improvements thereon. The improvements of claim 30 are the utilization of laminated filler material having layers of titanium and nickel and bonding at between 940°C and 1260°C for stainless steel to titanium implants. Applicants are aware of the advantages of utilizing stainless steel and titanium components in living tissue and improved upon alternative processes as taught in the Application. It is the improvements to the known, unsatisfactory bonding practices that Applicants teach. Claim 1 is allowable over the preamble of claim 30 by virtue of the limitation to the specific laminated filler material, which is not known in the art. [emphasis added]

Appellants argue that where the preamble of a Jepson claim describes

appellant's own work, such may not be used against the claims. MPEP 2129 III citing *Reading & Bates Construction Co. v. Baker Energy Resources Corp.*, 748 F.2d 645, 650; *Ehrreich*, 590 F.2d at 909-910, 200 USPQ at 510.

Accordingly, the rejection of claims 1-12 has been successfully overcome.

Even if the admitted prior art is considered as an eligible reference, it is nevertheless silent to the filler material being a composite comprising at least one foil layer of nickel and one foil layer of titanium. The admitted prior art does not teach this aspect of the invention.

The admitted prior art adds no additional elements that could make obvious that which Chang fails to teach.

D. Claim 13 stands rejected under 35 U.S.C. 103(a) as being unpatentable over admitted prior art in view of Chang et al. (US 6,722,002) as applied to claims 1-12 and in further view of Cusano et al. (US 3,994,430).

Incorporating the argument presented in section VII. C above, the rejection of claim 13 is overcome.

## VIII. CLAIMS APPENDIX

1. A component assembly suitable for use in living tissue comprising:

a stainless steel part;

a titanium part; and

a filler material comprising at least one nickel foil layer and at least one titanium foil layer for bonding said stainless steel part to said titanium part.

2. The component assembly of claim 1, wherein said at least one nickel foil layer is adjacent said titanium part.

3. The component assembly of claim 1, wherein:

said filler material has a top and a bottom outer surface; and

said at least one nickel foil layer comprises the top and the bottom outer surfaces of said filler material.

4. The component assembly of claim 1, wherein:

said filler material has a top and a bottom outer surface; and

said at least one titanium foil layer comprises the top and the bottom outer surfaces of said filler material.

5. The component assembly of claim 1, wherein said stainless steel part is selected from the group consisting of 200, 300, and 400 series stainless steel.

6. The component assembly of claim 1, wherein said stainless steel part is comprised of 316L stainless steel.

7. The component assembly of claim 1, wherein said titanium part is selected from the group consisting of titanium and titanium alloys.

8. The component assembly of claim 1, wherein said titanium part is comprised of Ti-6Al-4V.

9. The component assembly of claim 1, wherein said filler material reacts with and forms a bond between said titanium part and said stainless steel part.

10. The component assembly of claim 1 wherein:

said filler material has a thickness no greater than about 0.010 inches; and

said component assembly being heated to a temperature that is less than the melting point of said titanium part or of said stainless steel part, but that is greater than the melting point of said filler material, thereby forming a bond.

11. The component assembly of claim 1, wherein said at least one nickel foil layer and said at least one titanium foil layer are formed by a chemical process selected from the group consisting of electroless plating and electroplating.

12. The component assembly of claim 1, wherein said at least one nickel foil layer and said at least one titanium foil layer are formed by a thermal process selected from the group consisting of sputtering, evaporating, and ion beam enhanced deposition.

13. The component assembly of claim 1, wherein said at least one nickel foil layer and said at least one titanium foil layer are formed from metallic particulate.

## IX. EVIDENCE APPENDIX

A. Office action of December 13, 2005.

## X. RELATED PROCEEDINGS APPENDIX

None

## XI. SPECIFICATION APPENDIX

A. Specification with line numbers added and incorporating all Amendments.

B. Figures incorporating all Amendments.

Respectfully submitted,

5/11/06

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# APPENDIX XI.

## A. SPECIFICATION

# BRAZING TITANIUM TO STAINLESS STEEL USING LAMINATED Ti-Ni FILLER MATERIAL

## CROSS REFERENCE TO RELATED APPLICATION

This application is related to but in no way dependent on commonly assigned U.S. Patent Applications: Manufacturing Method for a Ceramic to Metal Seal, Application Serial No. 10/714,193; Layered Sphere Braze Material, Application Serial No. 10/793,457; Particulate Braze Material, Application Serial No. 10/793,006; and Brazing Titanium to Stainless Steel Using Nickel Filler Material, Application Serial Number 10/793,536, all incorporated in their entirety herein by reference.

## BRIEF DESCRIPTION OF THE DRAWINGS

**FIG. 1** illustrates a side view of the component assembly with filler material as a foil between the stainless steel part and the titanium part.

**FIG. 2** schematically depicts the bonding steps of the present invention.

**FIG. 3** presents an isometric view of a titanium-nickel laminated filler material having three foil layers.

**FIG. 4** presents an isometric view of a titanium-nickel laminated filler material having five foil layers.

**FIG. 5** presents an exploded isometric view of a ceramic tube, titanium part, and stainless part.

**FIG. 6** illustrates a bonded device with a crimp attached wire.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

**FIG. 1** presents component assembly 2 having a titanium part 4, a stainless steel part 6, and a filler material 8. Component assembly 2 is heated to a specific process temperature that is below the melting point of titanium part 4 or of the melting point of stainless steel part 6, for a specific period of time, at a

pressure that is created by force 10, that is exerted to place filler material 8 in intimate contact with the titanium part 4 and stainless steel part 6.

Filler material 8 is preferably a laminate metal foil having a thickness of approximately ten-thousandths (0.010) of an inch and more preferably less than 0.010 inches. Filler material 8 is selected from the group of materials that are compatible with the stainless steel chosen for stainless steel part 6 in that they wet the surface during the bonding process and enter into a diffusion process with the stainless steel part 6, thereby creating a strong bond joint during processing. Filler material 8 is further selected from the group of materials that are compatible with the titanium part 4. Filler material 8 forms a bond between titanium part 4 and stainless steel part 6 at the bonding temperature and pressure utilized during processing. The group of filler materials that are compatible with both the stainless steel part 6 and the titanium part 4 includes substantially pure titanium and nickel laminate compositions, preferably comprised of filler materials of about 22% to 98% nickel and the balance titanium. In a preferred embodiment, **FIG. 3**, filler material 8 is preferably comprised of alternating foil layers 12 and 14. Preferably, for example, as shown in **FIG. 3**, a laminate stack of commercially pure nickel layer 12 on the top outer surface 42 and a similar nickel layer 12 on the bottom outer surface 44. Sandwiched between the nickel layers 12 is a titanium layer 14. The nickel layer 12 having at least 99.0% nickel and less than 1.0% of other elements with a thickness of greater than approximately 0.0003 inches and the titanium layer 14 comprised of commercially pure titanium foil having at least 99.0% titanium and less than 1.0% of other elements with a thickness of greater than approximately 0.0003 inches.

The inventors prefer the term "laminated" versus other descriptive, but equally applicable, terms such as "layered", "clad", or "composite" material. The laminated filler material is not an "alloy" of nickel and titanium. An alloy, which is defined as a homogeneous mixture of two or more metals, where the atoms of

one replace or occupy interstitial positions between the atoms of the other, of nickel and titanium, for example, does not demonstrate the depressed melting point that is available at a eutectic composition when nickel and titanium are in intimate contact. The laminate material supplies substantially pure nickel to initiate bonding with other metals, such as titanium or stainless steel, for example, at relatively low eutectic temperatures. For example, the lowest liquidus temperature (also referred to herein as the melting point) in the nickel-titanium phase diagram occurs at 28% by weight nickel and is 942°C. Therefore, the optimum braze temperature will be greater than this temperature.

In a further preferred embodiment, **FIG. 4**, the metal foil layers 15, 15', and 15", which are comprised of nickel, are placed in laminated filler material 8 as the top outer surface 42 and as the bottom outer surface 44, thereby making the nickel available to react directly with the stainless steel part 6 and the titanium part 4. Alternating layers of inner mating foil layer 17 and 17', which are comprised of titanium, are placed between the metal foil layers 15, 15', and 15".

Those skilled in the art know that the total composition of a laminate stack of alternating nickel and titanium foil is controlled by the thickness of the foil layers, where the volume fraction of nickel and titanium is converted to weight percent by accounting for the density of the nickel and titanium. For example, to achieve a total laminate stack composition of a filler material 8 having a composition of 50 weight percent Ni and 50 weight percent Ti, where the density of nickel is 8.90 g/cc and of titanium is 4.51 g/cc, the thickness of the filler material 8 will be 33.6% Ni foil and 66.4% Ti foil.

Titanium part 4 may be comprised of a titanium alloy and is comprised of Ti-6Al-4V, i.e. an alloy of titanium with 6 weight percent aluminum and 4 weight percent vanadium, in a preferred embodiment. Stainless steel part 6 may be comprised of one of the corrosion resistant stainless steels, such as, 304 stainless steel, or a 200, 300, or 400 series stainless steel, and in a preferred

embodiment stainless steel part 6 is comprised of 316L stainless steel. This configuration of components offers the advantage of being biocompatible and of being capable of forming hermetic seals.

In an alternate embodiment, rather than using filler material 8 as a foil, filler material 8 may be a thin coating that is applied to the bonding surface of either the titanium part 4 or stainless steel part 6 by any of a variety of chemical processes, such as electroless plating and electroplating, or by any of a variety of thermal processes, such as sputtering, evaporating, or ion beam enhanced deposition.

In another embodiment, filler material 8 is applied as a thin coating of metallic beads, metallic powder, or discrete particles. The coating may be applied in any of several methods known to those skilled in the art, such as painting, spraying, or dipping. The applied coating consists of discrete particles of nickel and of titanium that aid in bonding the stainless steel part 6 and the titanium part 4 during the braze process.

The process steps that are employed to create component assembly 2 with a strong bond between titanium part 4 and stainless steel part 6 are schematically represented in **FIG. 2**. First, the surfaces to be bonded are prepared in step 20 by machining to assure that they will intimately conform to each other during bonding. The surfaces are smoothed and cleaned.

In step 22, component assembly 2 is prepared with filler material 8 between titanium part 4 and stainless steel part 6. In step 24, force 10 is applied to compress filler material 8 between titanium part 4 and stainless steel part 6. Force 10 is sufficient to create intimate contact between the parts. Force 10 is applied to assure that a bond is formed between titanium part 4 and stainless steel part 6, thus creating a hermetic seal between the two parts. It is preferred that the resulting pressure be greater than about five psi.

In step 26, the assembly to be heat processed is placed in a furnace in a non-reactive atmosphere, which is preferably vacuum, but which, in an alternative embodiment, can be any of several atmospheres that are known to those skilled in the art, such as argon, nitrogen or hydrogen. A non-reactive atmosphere is applied before the furnace is heated to the processing temperature in step 28. A preliminary holding temperature may be utilized to allow the thermal mass of the parts to achieve equilibrium before proceeding with heating. In a preferred embodiment, the vacuum is less than $10^{-5}$ torr, to assure that the filler material 8 and titanium part 4 do not oxidize. Component assembly 2 is held at the selected temperature, which is between approximately 940° and 1260°C, for approximately 5 to 60 minutes, while force 10 continues to be exerted on filler material 8. The exact time, temperature and pressure are variable with each other so as to achieve a strong bond between titanium part 4 and stainless steel part 6. For example, in a preferred embodiment, a 316L stainless steel part is bonded to a Ti-6Al-4V part in vacuum at $10^{-6}$ torr at approximately 1000°C for 10 minutes with a pressure of about 50 psi on a nickel-titanium foil of approximately 0.002 inches total thickness.

The furnace is cooled and component assembly 2 is cooled to room temperature in step 30. In optional step 32, component assembly 2 is cleaned by being placed in a bath, after thermal processing is complete, to assure removal of all nickel and nickel salts. This bath is preferably an acid bath that etches the exposed surfaces of component assembly 2. In a preferred embodiment, the bath is nitric acid. Removal of nickel and nickel salts in the etch bath insures that component assembly 2 is biocompatible. Nickel and nickel salts are detrimental to living animal tissue. It is preferred that all of the nickel that is introduced as filler material 8 is combined with the titanium and is chemically tied up by thermal processing to be unavailable as free nickel or as a nickel salt. Component assembly 2 is biocompatible after bonding and processing.

In a preferred embodiment, component assembly 2 is either an electrical sensor or an electrical stimulator that is implanted in a human body, although it could equally well be implanted in any animal. It must survive long periods in the hostile environment of a living body, which is basically a warm saline solution. In a preferred embodiment, component assembly 2 is either a sensor or stimulator comprised of a hollow ceramic tube 36, containing various electronic components, that is bonded to a titanium electrode end. The component assembly must be watertight, resisting salt-water intrusion as well as growth of living tissue into the titanium-to-stainless steel braze joint. **FIG. 5** presents an exploded isometric view of a ceramic tube 36 that is bonded to a titanium part 4 and a stainless steel part 6. The stainless steel part 6 is designed to accept an electrically conductive wire, for transmission of electrical signals.

Further, component assembly 2 does not corrode while implanted in the body. The materials are chosen such that post-bonding they are not susceptible to corrosion either individually or in the as-bonded state. Component assembly 2 resists electrolytic corrosion as well as crevice corrosion, because of the materials selected for construction of component assembly 2.

A bonded device 52 is presented in **FIG. 6** wherein a ceramic tube is bonded to titanium part 4 which is bonded to stainless steel part 6 with a filler material at braze joint 46. Stainless steel part 6 contains a receiver 54 into which a wire 50 is inserted and attached, preferably by crimping, such that crimp indentation 48 retains wire 50. The bonded device 52 provides good electrical conductivity via stainless steel part 6 connecting to wire 50. Stainless steel part 6 is brazed to titanium part 4 that is bonded by known methods to ceramic tube 36.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that,

within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

## CLAIMS

**What is claimed is:**

1. A component assembly suitable for use in living tissue comprising:

a stainless steel part;

a titanium part; and

a filler material comprising at least one nickel foil layer and at least one titanium foil layer for bonding said stainless steel part to said titanium part.

2. The component assembly of claim 1, wherein said at least one nickel foil layer is adjacent said titanium part.

3. The component assembly of claim 1, wherein:

said filler material has a top and a bottom outer surface; and

said at least one nickel foil layer comprises the top and the bottom outer surfaces of said filler material.

4. The component assembly of claim 1, wherein:

said filler material has a top and a bottom outer surface; and

said at least one titanium foil layer comprises the top and the bottom outer surfaces of said filler material.

5. The component assembly of claim 1, wherein said stainless steel part is selected from the group consisting of 200, 300, and 400 series stainless steel.

6. The component assembly of claim 1, wherein said stainless steel part is comprised of 316L stainless steel.

7. The component assembly of claim 1, wherein said titanium part is selected from the group consisting of titanium and titanium alloys.

8. The component assembly of claim 1, wherein said titanium part is comprised of Ti-6Al-4V.

9. The component assembly of claim 1, wherein said filler material reacts with and forms a bond between said titanium part and said stainless steel part.

10. The component assembly of claim 1 wherein:

said filler material has a thickness no greater than about 0.010 inches; and

said component assembly being heated to a temperature that is less than the melting point of said titanium part or of said stainless steel part, but that is greater than the melting point of said filler material, thereby forming a bond.

11. The component assembly of claim 1, wherein said at least one nickel foil layer and said at least one titanium foil layer are formed by a chemical process selected from the group consisting of electroless plating and electroplating.

12. The component assembly of claim 1, wherein said at least one nickel foil layer and said at least one titanium foil layer are formed by a thermal process selected from the group consisting of sputtering, evaporating, and ion beam enhanced deposition.

13. The component assembly of claim 1, wherein said at least one nickel foil layer and said at least one titanium foil layer are formed from metallic particulate.

**BRAZING TITANIUM TO STAINLESS STEEL USING LAMINATED Ti-Ni FILLER MATERIAL**


## ABSTRACT

A method of bonding a stainless steel part to a titanium part by heating a component assembly comprised of the titanium part, the stainless steel part, and a laminated titanium-nickel filler material placed between the two parts and heated at a temperature that is less than the melting point of either the stainless steel part or the titanium part. The component assembly is held in intimate contact at temperature in a non-reactive atmosphere for a sufficient time to develop a hermetic and strong bond between the stainless steel part and the titanium part. The bonded component assembly is optionally treated with acid to remove any residual free nickel and nickel salts, to assure a biocompatible component assembly, if implanted in living tissue.

APPENDIX XI.

B. DRAWINGS

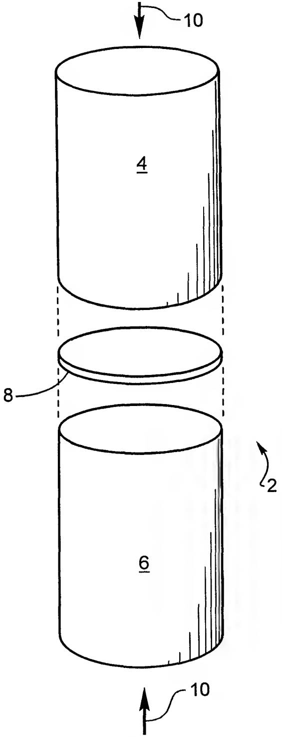

10
4
8
2
6
10

*Fig. 1*

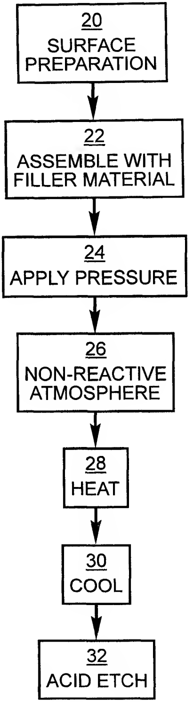

20 SURFACE PREPARATION
22 ASSEMBLE WITH FILLER MATERIAL
24 APPLY PRESSURE
26 NON-REACTIVE ATMOSPHERE
28 HEAT
30 COOL
32 ACID ETCH

*Fig. 2*

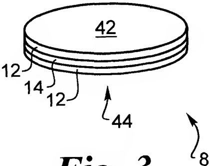



*Fig. 3*

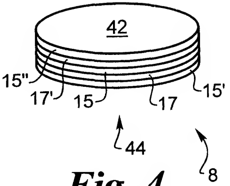
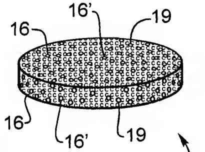
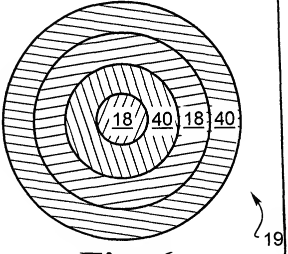



*Fig. 4*




[*Fig. 5*
canceled]




[*Fig. 6*
canceled]

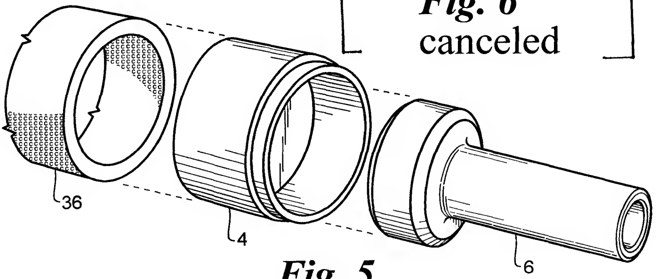



*Fig. 5*
[amended fig number]

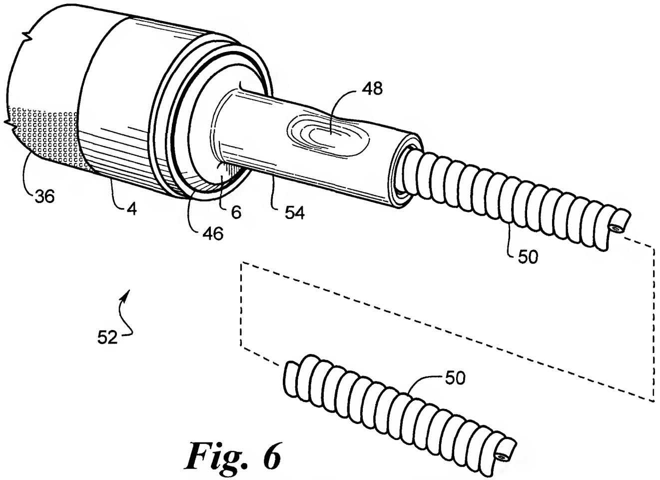



***Fig. 6***
[amended fig number]

## CERTIFICATE OF MAILING

I hereby certify that, on the date shown below, this correspondence is being:

EFS-WEB filed in the Patent and Trademark Office.

Signature

Date: 16 May, 2006

GARY SCHNITTGRUND

(type or print name of person certifying)